Efficient Power Management for Group Tour Guide by RFIDs in Wireless Sensor Networks

D.Dinesh[1], Dr.T.Sasilatha[2]

[1] *Research scholar-parttime,AnnaUniversity,Chennai*

[2] *Professor&Head /ECE (Sree Sastha Inst of Engineering and Tech)*

Abstract: **Energy management in sensor networks is essential to prolong the network lifetime. The group guiding services based on RFIDs and wireless sensor network has a sensing field mixed with multiple independent tourist groups, each with a leader and several members. Sensor nodes have to track leaders' locations and maintain following paths from members to leaders. In order to manage the power in this scheme, EGGSS protocol (Efficient group guiding sleep scheduling protocol) is proposed. The protocol applies the TDMA based sleep scheduling to enable reliable group guiding at low cost, low traffic load and at low power.**

Keywords: **Energy management, Wireless sensor networks, sleeps scheduling, Group guiding system**

I. Introduction

A wireless sensor network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure etc. and to cooperatively pass their data through the network to a main location. The sensor nodes are typically equipped by power-constrained batteries, which are often difficult and expensive to be replaced once the nodes are deployed. Power saving is one of the most important features for the sensor nodes to extend their lifetime in wireless sensor networks. A sensor node consumes mostly its energy in transmitting and receiving packets. In order to increase energy efficiency and extend the network lifetime, new and efficient power saving algorithms must be developed. Sleep scheduling is a widely used mechanism in wireless sensor networks (WSNs) to reduce the energy consumption since it can save the energy wastage caused by the idle listening state. In recent years, the integration of RFIDs and wireless sensor networks (WSNs) is very useful in many applications. Based on passive or active radio frequency technologies, RFIDs can support identification at low cost [1]. On the other hand, a WSN consists of many tiny, multi-functional, low-power, autonomous nodes with integrated sensing, processing, and communication capabilities [2], [3]. In the group guiding system [4], a WSN is deployed for the purpose of location tracking by measuring signals emitted by user badges. Each tourist group has one tour guide and some members. Only the tour guide carries a badge, which can emit signals for the location-tracking purpose. For economical purpose, each member simply carries a ticket tagged with a passive RFID tag. Therefore, only the locations of tour guides can be tracked. Since the system must have some user interfaces, each node in the WSN is equipped with a "direction board", which contains a LED panel that can show some basic information. Also, some sensor nodes are designated as "help centers", each of which is connected to a RFID reader and a laptop, to provide more in-depth guiding services.

The communication protocol used in the sensor networks should be light weight and should not consume more energy. Sensor node in WSN is small, its power supply unit should be very small and also it should support all its operations without degrading the performance. Hence, we are going for a good scheduling protocol and while applying it, power consumption is the one which should be kept in mind. The authors in [5], [6] has shown that the idle listening state is the major source of energy wastage. In fact, it can consume almost the same amount of energy as required for receiving. Therefore, nodes are generally scheduled to sleep when the radio modules are not in use [7]. After the sleep scheduling, nodes could operate in a low duty cycle mode that they periodically start up to check the channel for activity.
Keshavarzian et al. [8] analyzed different sleep scheduling schemes and proposed a scheduling method that can decrease the end-to-end overall delay. This method did not, however, provide an interference-free scheduling, in which every node can start up and transmit or receive its messages without interference during the assigned time slots. One popular approach to avoid interference is to adopt the time division multiple access (TDMA) MAC protocols, which can directly support low duty cycle operations and has the natural advantages of having no contention-introduced overhead and collisions. TDMA can guarantee a deterministic delay bound. Thus, we are interested in designing an efficient TDMA sleep scheduling for WSNs. TDMA protocols divide time into slots, which are allocated to sensor nodes that can turn on the radio during the assigned

time slots, and turn off the radio when not transmitting or receiving in the sleep scheduling. In order to be interference free, a simple approach is to assign each communication link a time slot, and thus, the number of time slots is equal to the number of communication links of the network. This scheme requires much more time slots than necessary, which increases the delay and reduces the channel utilization significantly. This is because multi-hop networks are able to make space reuse in the shared channel, and multiple transmissions can be scheduled in one time slot without any interference. Several approximate algorithms have been proposed in the link scheduling problem [9]–[12]. However, if the TDMA link scheduling is used as the startup mechanism in the sleep scheduling, a node may start up numerous times to communicate with its neighbors. The normal startup time is on the order of milliseconds, while the transmission time may be less than that if the packets are small [13]. Consequently, the transient energy consumption during the startup process can be higher than the energy during the actual transmission. If a sensor node starts up too frequently, it not only needs extra time, but also costs extra energy for the state transition. Therefore, the state transition, e.g., from the sleep state to the active state, should be considered for an energy efficient TDMA sleep scheduling in WSNs. In this paper, we use a new energy model, where the energy consumption of the state transition is considered. The proposed protocol is helpful in finding the group leaders at low power, maintaining the movement of the path at low power and providing the navigation services with low power consumption.

III Group Guiding System

A WSN is deployed in a sensing field with one or multiple tourist groups. Each group has one leader and some members. The system provides the following services: (i) tracking the locations of leaders, (ii) maintaining the guiding paths to each leader, (iii) showing guiding paths for lost members, and (iv) helping leaders call their members. The system architecture is shown in Fig. 1.

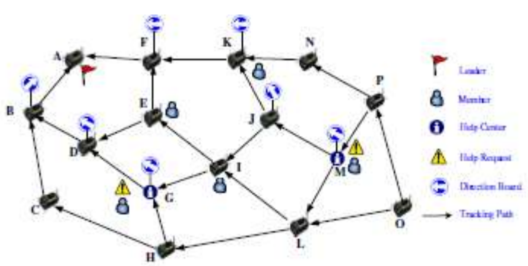

Figure 1 System Architecture

Each group leader carries a badge that can emit 4 kHz audio signals to allow the WSN to track its location. Each group member simply carries a ticket with a passive RFID tag containing a group ID. Each sensor node is attached to a direction board for displaying simple guiding direction. Some nodes in the WSN are designated as help centers, each connected to a laptop and a RFID reader. A group guiding protocol is run at each sensor node. The three service scenarios of this system are given below:

1. Leader tracking: At normal time, each badge will broadcast signals periodically. Sensor nodes cooperate to track the locations of group leaders and maintain the guiding path from each sensor node to each leader. Examples of tracking paths are shown in Fig. 1.
2. Help service: When a member gets lost, he/she can go to any help center and present his/her ticket to the RFID reader. Then guiding directions can be shown on the screen of the help center as well as the direction boards of those sensors which form a guiding path toward the sensor that is tracking the leader. Fig. 1 shows some help centers and direction boards.
3. Member-Recall: A group leader can also call his/her members back by pushing a button on the badge. A broadcast message will be flooded to the network. All direction boards on sensors will show the guiding directions to the sensor that is tracking the leader.

A. Leaders' Badges

Each badge will periodically broadcast audio signals for theWSN to track its location. We avoid using RF transmitters to keep the cost low. A badge is composed of a buzzer, a switch circuit, a control module, some control buttons, and a power supply.

B. Sensor Nodes

The sensor nodes are realized by *MICAz* motes, which can sense sounds through their microphones. Each sensor node is connected to a direction board, which is an 8×8 LED matrix

C. Help Centers

A help center is a laptop connected to a sensor node and a RFID reader First, given a group ID, it will find the location of the group leader and ask sensors on the path toward the leader to display instructions on their direction boards. Second, the navigation paths will also be shown on its screen so that the user can have a global view about leader location.

IV Proposed System model

The objectives of the proposed protocol with sleep scheduling are as follows

(i) Most sensor nodes should be in sleep mode most of the time so that the energy consumption by each node is reduced.

(ii) Time required to transmit data is as minimum as possible.

In our model, we assume that each node operates in three states: active state (transmits, receive and listen), sleep state, and transient state (state transition). The energy consumption of sensor nodes in the sleep state is much less than the consumption in the active state, and a significant energy saving can be achieved if the sleep state is employed during the periods of inactivity. The transient state comprises two processes: startup (from the sleep state to the active state), and turndown (from the active state to the sleep state). The energy model is illustrated in Fig. 1 (a), and there is a significant energy consumption and time overhead when the sensor's radio powers on and off. Fig. 1 (b) shows that merging the sensor's active time slots together can reduce the startup frequency so as to save both energy and time, which benefits the duty cycle network design.

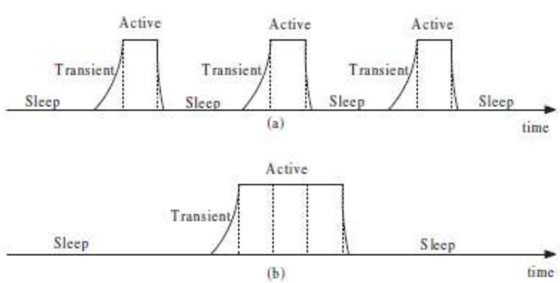

Figure 2 The energy model: (a) Before active time slots merged, (b) After active time slots merged

Location tracking

Each sensor in the WSN has three states: tracker, non-tracker and candidate. The sensor that is monitoring the leader badge L_i is called L_i's tracker. (For each badge L_i, only one sensor serves as its tracker, but a sensor can serve as a tracker for multiple badges.) The other sensors are non-trackers or candidates. The sensor in the candidate state is one which is trying to become a tracker.

For each sensor node the state is checked. (Tracker, non-tracker or candidate) If it is in tracked mode, then the sensor node moves to the active state. Next if the state is in the non-tracker state it moves to the transient state (active state to sleep state). When sensor node is in the candidate state the sensor node moves to the sleep state. Again when the node becomes tracker for any leader badge the node shifts to the active state. Here the transient state is from sleep to active state.

Help Service

When a member gets lost, he/she can go to any help center N_h, and present his/her ticket to the RFID reader. The N_h node remains in sleep state until it receives the help request. Here the help request act as wake up signal to the N_h. On receiving such a request, the help center sensor node N_h goes to active state. Then it broadcast the Help_Req message to all the nodes in the networks. The Help_Req(Li, Path, Nh) message contains the Leader badge L_i, path information and help node id N_h. On receiving the message the corresponding tracker node of L_i sends the Reply signal to the node N_h and to all the nodes that in that path direction. The Reply signal acts as the wake up signal for the nodes in the path. The path nodes wake up from the sleep state to active state and display direction. The $N_{h\ \text{dislay}}$ the direction information of the leader for a few time period then it transit to the sleep state.

Pseudocode for Location tracking:

```
Begin
  Repeat  for I = 1 to Gno.

        If NSTATE = 'TRACKER'
            NODE → ACTIVE
        Else if  NSTATE = ' NONTRACKER'
            NODE → TRANSIENT
        Else
            NODE → SLEEP
End
```

ReCall Service

In case of member recall as soon as the tracker node of leader receives the RECALL signal the tracker wake the path nodes so that the path nodes that are in sleep state transit to active state and display the direction information. It remains in that state for a particular time then switch to sleep states.

Pseudocode for Help service:

```
Begin

        If RFID = 'VALID'
             HNODE → ACTIVE
             Broadcast HELP_REQ(Li, Path, Nh )

             If NODE = 'TRACKER_i'
                 Send REPLY to HNODE, PNODES
                 PNODES → ACTIVE
                 PNODES display direction
                 HNODE display direction
                 HNODE→SLEEP
                 PNODES → SLEEP

            Else
             NODE LOST
   End
```

V Performance Evaluation

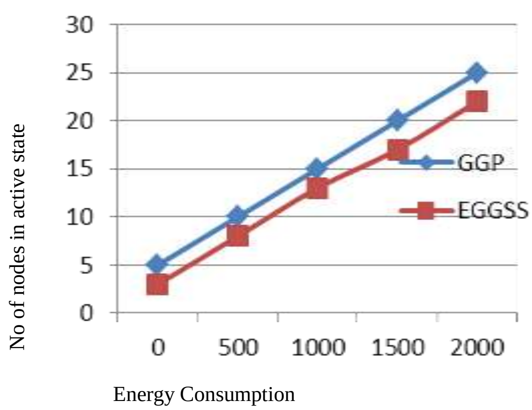

Figure 3 Energy consumption Comparison

Figure 3 compares the energy consumption for our routing protocol with the Group Guiding protocol that is implemented without energy saving. It is clear that, EGGSS protocol provides the energy efficiency for the group guiding protocol.

VI Conclusion

In this paper, we propose a novel protocol named efficient group guiding sleep scheduling protocol (EGGSS protocol) for improving the power management for group tour guide by RFIDs and wireless sensor networks. The protocol is TDMA based sleep scheduling that enables the tracking group leaders at low power, maintaining the path movement at low power and providing the navigation services with low power consumption.

References

[1] R. Weinstein, "RFID: a technical overview and its application to the enterprise," *IEEE IT Professional*, vol. 7, no. 3, pp. 27–33, May 2005.

[2] I. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "A survey on sensor networks," *IEEE Commun. Mag.*, vol. 40, no. 8, pp. 102–114, Aug. 2002.

[3] M. Tubaishat and S. Madria, "Sensor networks: an overview," *IEEE Potentials*, vol. 22, no. 2, pp. 20–23, Apr./May 2003.

[4] P. Y. Chen, W. T. Chen, C. H. Wu, Y.-C. Tseng, and C.-F. Huang, Providing Group Tour Guide by RFIDs and Wireless Sensor Networks, IEEE Transactions on wirelesscommunications , Vol 8, No. 6, June 2009

[5] W. Ye, J. Heidemann, and D. Estrin, "An energy-efficient MAC protocol for wireless sensor networks," in *Proc. of IEEE INFOCOM*, 2002.

[6] T. Dam and K. Langendoen, "An adaptive energy-efficient MAC protocol for wireless sensor networks," in *Proc. of the First ACM Conference on Embedded Networked Sensor Systems (SenSys)*, 2003.

[7] Y. Sun, S. Du, O. Gurewitz, and D. B. Johnson, "DW-MAC: a low latency, energy efficient demand-wakeup MAC protocol for wireless sensor networks," in *Proc. of ACM MobiHoc*, 2008.

[8] A. Keshavarzian, H. Lee, and L. Venkatraman, "Wakeup scheduling in wireless sensor networks," in *Proc. of ACM MobiHoc*, 2006.

[9] S. Ramanathan and E. L. Lloyd, "Scheduling algorithms for multihop radio networks," *IEEE/ACM Transactions on Networking*, vol. 1, no. 2, pp. 166–177, 1993.

[10] S. Gandham, M. Dawande, and R. Prakash, "Link scheduling in sensor networks: Distributed edge coloring revisited," in *Proc. of IEEE INFOCOM*, 2005.

[11] W. Wang, Y. Wang, X. Y. Li, W. Z. Song, and O. Frieder, "Efficient interference-aware TDMA link scheduling for static wireless networks," in *Proc. of ACM MobiCom*, 2006.

[12] P. Djukic and S. Valaee, "Link scheduling for minimum delay in spatial re-use TDMA," in *Proc. of IEEE INFOCOM*, 2007.

[13] A. Wang, S. Cho, C. Sodini, and A. Chandrakasan, "Energy efficient modulation and MAC for asymmetric RF microsensor systems," in *Proc. of the 2001 International Symposium on Low Power Electronics and Design (ISLPED)*, 2001.